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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/712,740	11/13/2003	In Kyu Chun	20059/PIA30957	8888

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EXAMINER

MALSAWMA, LALRINFAMKIM HMAR

ART UNIT	PAPER NUMBER
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2823

DATE MAILED: 07/26/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/712,740

Applicant(s)

CHUN, IN KYU

Examiner

Lex Malsawma

Art Unit

2823

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 11 July 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-6 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-6 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 13 November 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on July 11, 2005 has been entered.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Modak** (6,537,913 B2) in view of **Liu** (6,211,085 B1).

Regarding claim 1:

Modak discloses a method of forming a Cu line in semiconductor fabrication, comprising:

forming a dual damascene pattern (Fig. 1a) by etching a PMD 101 layer formed on a substrate 100, wherein the dual damascene pattern includes a contact hole portion 103 located on

the substrate and a trench portion 104 located on the contact hole portion, the width of the contact hole portion being narrower than that of the trench portion;

depositing a “first” diffusion barrier 106 (Fig. 1b and Col. 3, lines 4-6) on sidewalls of the dual damascene pattern;

filling the dual damascene pattern with “a first metal” 105 (copper) by depositing the first metal on the first diffusion barrier to form a first metal layer;

chemical mechanical polishing a portion of the first metal layer 105 over the trench portion (Col. 3, lines 23-26);

etching the upper part of the first metal layer in the trench portion **so as to not expose a void in the contact hole, thereby forming** a first-metal plug 111 (Fig. 1c and Col. 4, lines 10-14) that occupies a lower part of the first metal layer in the trench portion and the contact hole portion (Fig. 1c, **note that the etching is performed only in the upper part of the trench portion and the etching does not reach the contact-hole portion, therefore no void is exposed in the contact-hole portion of the dual-damascene pattern**);

depositing a second diffusion barrier 107 on the first-metal plug 111 (Fig. 1d); and

depositing a second metal 108 on the second metal diffusion barrier 107 (Fig. 1d).

Modak **lacks** the “first metal layer 105” being tungsten and the “second metal layer 108” being copper. However, it is important to note that Modak discloses the essential process steps/sequence of the current claim; and the only essential difference between the Modak and the current invention seems to be in preferred materials for the first and second metal layers.

Furthermore, it is important to note that Modak specifically discloses (in Col. 5, lines 22-29),

“[a]lthough the foregoing description has specified certain...materials..., those skilled in the art

will appreciate that many modifications and substitutions may be made". Liu is cited primarily to show it was very well known in the art that a dual-damascene-contact structure may be formed by specifically incorporating tungsten (i.e., wolfram 80) and copper 94 (note Figs. 4-6 and Col. 4, lines 44-62), wherein tungsten is used in a contact hole portion (i.e., used as a first metal layer) and copper is used to fill a trench portion of the dual-damascene-contact structure (i.e., the copper is used as a second metal layer).

In sum, Modak discloses the essential process steps of the claimed invention and specifies that many substitutions may be made at least for the materials specified in the disclosure. Liu shows that the specific materials (W and Cu) recited in the claimed invention are well known to be suited for a dual-damascene-contact structure. Accordingly, it would have been obvious to one of ordinary skill in the art to modify Modak by specifically utilizing materials such as W and Cu because Liu shows that such materials are well-known to be suited for a dual-damascene-contact structure, and it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter obvious design choice. In re Leshin, 125 USPQ 416.

4. Claims 2-4 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Modak** (in view of **Liu**) as applied to claim 1 above, and further in view of Huang et al. (5,527,736; hereinafter, "**Huang**").

Regarding claim 2:

Modak (in view of Liu) lacks performing dry-etching process on the first metal layer 105; however, it is noted that Modak specifies a wet-etching process is used primarily because

the first metal layer is specifically copper (Col. 4, lines 10-14). Huang **teaches** that it is conventional in the art to utilize dry etching when forming a recessed tungsten plug 24 within a contact hole (note Figs. 2, 5, Col. 1, lines 31-33; and Col. 2, lines 57-60). Given that Modak (in view of Liu) incorporates a tungsten layer to provide a tungsten plug, it would have been obvious to one of ordinary skill in the art to specify a dry-etching process performed on the tungsten layer (of Modak in view of Liu) because Huang teaches that it was conventional in the art to etch tungsten by dry etching.

Regarding claims 3 and 4:

Modak discloses the first diffusion barrier 106 includes titanium nitride and the second diffusion barrier layer 107 includes tantalum nitride (Col. 3, lines 4-6 and Col. 4, lines 25-28); **and Liu also discloses that a suitable diffusion barrier 90 includes Ta, TaN or TiN (Figs. 5-6 and Col. 4, lines 53-55).**

5. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Modak** (in view of **Liu** and **Huang**) as applied to claim 4 above, and further in view of Gupta et al. (6,114,243; hereinafter, "**Gupta**").

Regarding claim 5:

Modak (in view of Liu and Huang) discloses the height of the second metal layer 109 can be about 200 nm (note Modak, Col. 4, lines 52-54); however, Modak (in view of Liu and Huang) **lacks** specifically disclosing a thickness for the first metal plug 105. Gupta is **cited only to show** that for an "upper recess" of a dual-damascene pattern having a thickness of about 200 nm (as in Modak), the "entire" dual-damascene opening would have a height of about 200nm to 2000 nm

(note Gupta, Col. 3, lines 39-42), i.e., Gupta shows ranges similar to, or including, the claimed ranges.

Modak (in view of Liu and Huang) discloses the general conditions of the claimed invention except for the specific ranges in heights (250 nm and 300 nm) for the dual damascene contact structure; however, given that Gupta shows that a wide range in heights could be chosen apparently according to design needs, it would have been obvious to one of ordinary skill in the art to specify ranges as currently claimed because the ranges would depend on a particular design requirement (e.g., the range could depend on such things as the type of device being fabricated or a desired packing density for the devices, etc.). It is noted that no particular type of device or other critical device parameters (e.g., gate lengths, distances between devices, etc.) have been claimed such that the claimed ranges could be given significant patentable weight. Accordingly, the claimed ranges are considered to be an optimum or workable range for some particular design requirement. Note that it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233.

6. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Modak** (in view of **Liu, Huang and Gupta**) as applied to claim 5 above, and further in view of Wang et al. (6,184,128 B1; hereinafter, "**Wang**").

Regarding claim 6:

Modak (in view of Liu, Huang and Gupta) is silent with respect to diameters of the first metal plug (in the contact hole) and the lower part of the trench portion, i.e., Modak (in view of

Liu, Huang and Gupta) **lacks** diameters of 185 nm and 500nm for the contact hole portion and the lower part of the trench portion, respectively. Wang is cited **only to show** that contact openings and trench openings within a dual-damascene contact structure can be formed to have any desired cross-sections, including dimensions similar to those currently recited (note Wang, Col. 6, lines 52-58 and Col. 7, lines 41-48).

Modak (in view of Liu, Huang and Gupta) discloses the general conditions of the claimed invention except for the specific ranges in diameters (185 nm and 500 nm) for the dual damascene contact structure; however, given that Wang shows that diameters within a dual damascene contact structure can be formed to have any desired cross-section, it would have been obvious to one of ordinary skill in the art to specify ranges as currently claimed because the ranges are considered to be an optimum or workable range for some particular design requirement. Note that it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233.

Remarks

7. Applicant's remarks/arguments have been carefully reviewed and considered but they are not persuasive. Applicant submits that, in claim 1, "only the upper part of the tungsten layer in the trench portion is etched and, as a result, any void in the contact hole portion is not exposed by the etching operation" (applicant's remarks, page 5, lines 1-3). Applicant further submits that "neither Modak nor Liu discloses or suggests a method for forming a contact using a Cu line in a semiconductor comprising etching an upper part of a tungsten layer in a trench portion so as to

not expose a void in a contact hole portion” (page 4, 3rd paragraph). As noted above, with respect to claim 1, Modak discloses etching only an upper part of “the first metal” 105 within the trench portion of the dual-damascene pattern (note Figs. 1b-1c), i.e., Modak’s etching never reaches the contact-hole portion of the dual-damascene pattern; accordingly Modak’s etching process will not expose a void in the contact-hole portion. Therefore, Modak discloses all essential process steps recited in claim 1, and the only elements lacked by Modak are the specific materials (i.e., material combination of tungsten and copper). As explained in detail above, Modak in view of Liu renders obvious the specific material combination (of tungsten and copper) recited in claim 1. Therefore, applicant’s remarks/arguments are not persuasive and all pending claims stand rejected 35 USC § 103.

In sum, insofar as process sequence and steps, Modak’s disclosure and the current invention are essentially the same. The only distinction between Modak and the current invention seems to reside in the specific combination of materials recited in the current claims; however, the combination of materials disclosed in the current invention is held obvious over Modak in view of Liu primarily because Modak specifically states that those skilled in the art will recognize that many modifications and substitutions may be made at least with respect to materials used in the dual-damascene contact structure (Col. 5, lines 22-26), and Liu shows that the combination of materials was well known to be suited for a dual-damascene contact structure.

Conclusion

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lex Malsawma whose telephone number is 571-272-1903. The examiner can normally be reached on Mon. - Thur. (4-12 hours between 5:30AM and 10 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith can be reached on 571-272-1907. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).


Lex Malsawma

July 23, 2005